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Prognostic factors between the proximal femoral nail and bipolar hemiarthroplasty in femoral intertrochanteric fractures

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ABSTRACT

Aim: In the treatment of intertrochanteric femur fractures, proximal femoral nail (PFN), and bipolar hemiarthroplasty (BPH) are widely used. This study aimed to compare these two types of implants depending on risk factors regarding patients.

Material and Method: PFN (Group 1) was applied to 40 of the 89 patients (44 female, 45 male) aged between 51-80 (mean 68.16±6.78) and BPH (Group 2) was applied to 49 of them. Age, gender, fracture side, fracture mechanism, additional disease, Body mass index (BMI), Albumin level, Hemoglobin (Hb) decrease level, T-score, American Society of Anesthesiologists (ASA) classification, type of anesthesia, surgery type, operation time, hospital stay and full weight-bearing time, Harris Hip Score (HHS) in preoperative and postoperative periods, classification of intertrochanter fracture according to the AO Foundation and Orthopedic Trauma Association (AO/OTA), postoperative complications were recorded.

Results: Group 1 was younger with a mean age of 64.55±6.23 years compared to Group 2 ($p < 0.05$). Most of the fractures were 3A2 type and the result of low energy ($p > 0.05$). In group 1, operation time was 46.78±5.29 minutes and hospital stay was 2.48±0.75 days, which was shorter, most surgery types were closed, T-score was -2.49±0.59 and better, the time of full weight-bearing was 3.48±0.78 months, Hb decrease was 1.17±0.37 g/dL and less, Albumin level was 3.11±0.4 g/dL and higher ($p < 0.05$). In Group 2, the age was the highest (72.6±5.2) and the T score was the lowest (-2.9±0.4) in the 3A2 fracture type ($p < 0.05$). HHS was better in the BPH group at the sixth month ($p < 0.05$), and there was no difference between the two groups at the end of one year ($p > 0.05$).

Conclusion: Prognostic markers for treatment outcomes in individuals with intertrochanteric fractures are still unknown. It is important to determine the factors that will contribute to the long-term functional results in these patients.

Keywords: Intertrochanteric femur fracture, proximal femoral nail, bipolar hemiarthroplasty, prognostic factors, functional outcomes

INTRODUCTION

With the aging population, the rise in additional diseases such as osteoporosis increases the incidence of hip fractures (1). Fractures of this region bring along functional disorders. Most of the patients can not return to premorbid mobility levels. Millions of people experience major problems due to these fractures, which put a heavy burden on the health system (2). Intertrochanteric femur fractures constitute 50% of hip fractures and the mortality rate within a year is 15-20%. This type of patient is accompanied by many morbidities such as diabetes, lung, heart, hypertension, and low general condition. Therefore, the surgery of these patients is important because of the complications and results (3). Biomechanical studies make intramedullary implants suitable for trochanteric fractures due to their load-bearing and high mechanical resistance properties (4). However, some patient-related features may prevent using these implants all the time. Bipolar hip prostheses are widely used in trochanteric region fractures, especially in unstable fractures (5). Functional results vary from the position of the implant in the femoral neck to the course of the fracture and patient data. Osteosynthesis in the correct position provided by the implant can procure a good union and minimize mechanical complications (6).

The aim of this study was to evaluate the prognostic markers that affect the functional outcomes of PFN or

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cementless BPH, which we performed in patients with an intertrochanteric femur fracture, by comparing the risk factors affecting these results.

MATERIAL AND METHOD

This study was designed as a retrospective cohort study. This study was approved by İstinye University Clinical Researches Ethics Committee (Date: 03.03.2022; Decision No: 3/2022.K-21). All procedures were performed by the ethical rules and principles of Declaration of the Helsinki.

Between the years 2017-January and 2019-November, 103 patients who had PFN or cementless BPH surgery were recorded and analyzed in our hospital with the diagnosis of intertrochanteric femur fracture. Those with pathological fractures, multiple fractures, who did not come to the controls and we could not reach were excluded from the study. 89 patients constituted the study group. Age, gender, fracture side, fracture mechanism (low-high energy), additional disease, BMI, Albumin level, Hb decrease level (Hb level difference before and after the operation without blood transfusion) of all patients, T-score for osteoporosis, also ASA classification, type of anesthesia, surgery type (open-closed), operation time, hospital stay and full weight-bearing time, HHS in preoperative and postoperative periods, classification of intertrochanter fracture according to AO/OTA, postoperative complications were recorded using the hospital archive and patient controls (**Table 1**).

The AO-OTA classification and the patient ages were divided into 3 groups as 3A1, 3A2, 3A3, and 50-60, 61-70, 71-80. Additional diseases of the patients were Diabetes mellitus (DM), cardiac–hypertension, pulmonary, and neurologic. Those with BMI ≥ 25 kg /m² were overweight, albumin level between 3,4-5,4 g/dl was normal, and those with T-score ≤ -2.5 were osteoporosis. Postoperative complications were recorded regarding wound infection, deep vein thrombosis (DVT), urinary-pulmonary infection, bedsore, and implant-related.

HHS (7); Components are pain, function, range of motion, and deformity. The function is separated into two categories: activities of daily living and gait. The meaning of scores: 90–100 excellent, 80–89 good, 70–79 fair, and <70 poor. It was evaluated preoperatively and at 6, 12 months postoperatively.

Statistical Analysis

SPSS 21.0 program was used in the analysis. The chi-square test was used to examine the association between categorical variables. The correlation test was used to examine the relationship among numerical variables. The difference between the numerical variables according to the categorical variables with two groups was analyzed with the t-test, and the difference between the categorical variables with three or more groups was analyzed with the ANOVA test. The statistical level of significance was established at p <0.05.

Table 1. The relationship between the implant types and the clinical features of patients

	PFN		BPH		p value
	N	%	N	%	
Age (Years)					.015*
50-60	13	32.5	5	10.2	
61-70	14	35.0	16	32.7	
71-80	13	32.5	28	57.1	
Mean±Sd	64.55±6.23		71.12±5.74		
Gender					.602
Female	21	52.5	23	46.9	
Male	19	47.5	26	53.1	
Side					.098
Right	25	62.5	22	44.9	
Left	15	37.5	27	55.1	
AO-OTA					.181
3A1	14	35	17	34.6	
3A2	20	50	30	61.2	
3A3	6	15	2	4.0	
Anesthesia					.806
Spinal	35	87.5	42	85.7	
General	5	12.5	7	14.3	
Fracture mechanism					.606
Low energy	30	75	39	79.6	
High energy	10	25.0	10	20.4	
Surgery type					.001*
Open	3	7.5	49	100	
Closed	37	92.5	-	-	
Additional illness					.652
Only one	8	30.8	12	36.4	
>1	18	69.2	21	63.6	
Postoperative complication					
Wound Site	4	30.8	1	20.0	.636
DVT	2	15.4	2	40.0	
Urinary-pulmonary infection	1	7.7	1	20.0	
Bedsore	4	30.8	1	20.0	
Implant related	2	15.4	-	-	
	Mean ±Sd		**Mean ±Sd**		
Operation time (minutes)	46.78 ±5.29		58.73±7.01		.001*
Hospital stay (day)	2.48±0.75		4.59±1.0		.001*
BMI	26.5±4.14		26.94±4.29		.627
ASA	2.63±0.63		2.84±0.59		.105
T-score	-2.49±0.59		-2.83±0.5		.004*
Full weight - bearing (month)	3.48±0.78		postoperative day		.001*
Hb decrease (g/dL)	1.17±0.37		2.05±0.45		.001*
Albumin (g/dL)	3.11±0.4		2.84±0.33		.001*

PFN: proximal femoral nail BPH: bipolar hemiarthroplasty AO-OTA: AO Foundation and Orthopedic Trauma Association BMI: body mass index ASA: American Society of Anesthesiologists classification Hb: hemoglobin Sd: Standard deviation, *Significance; p<0,05

RESULTS

The mean follow-up time of 89 patients (44 female, 45 male) aged between 51-80 (mean 68,16±6,78) was 28.6 (range 24-33) months. PFN (Group 1) was applied to 40 of the 89 patients and cementless BPH (Group 2) was applied to 49 of them. PFN patients were younger with an average age of 64.55±6.23 compared to those who underwent BPH (p <0.05), there was no difference between the two groups concerning gender (p> 0.05). Most of the fractures were 3A2 type according to AO-OTA and were the result of low energy, and there was no difference among the fracture sides (p>0.05). Spinal anesthesia was applied to most of the patients in the two groups, and most of the patients had more than one additional disease. although postoperative complications were higher in group 1, there was no significant difference between the two groups (p>0.05) (**Table 1**).

In group 1, operation time was 46.78±5.29 minutes and hospital stay was 2.48±0.75 days, which were shorter, most surgery types were closed, T-score was -2.49±0.59 and better, the time of full weight-bearing was 3.48±0.78 months, Hb decrease was 1.17±0.37 and less, Albumin level was 3.11±0.4 g/dL and higher (p<0.05). The mean BMI was >25 kg/ m^2 in both groups, and there was no difference between ASA scores (p>0.05) (**Table 1**).

When we examined the AO-OTA fracture type in two groups with various factors, in the BPH group, the age was the highest (72.6 ±5.2) and the T score was the lowest (-2.9±0.4) in the 3A2 fracture type. The age was the lowest (64.0±5.6) and T score was the best (-2.4±0.5) in patients with 3A3 fracture type who had BPH (p<0.05). We found no difference in these parameters in the PFN group (P>0.05). Most of the 3A1 and 3A2 fracture types in the PFN group were performed with low energy and the 3A3 type with high energy (p<0.05). We did not detect such a difference in the BPH group. There was no significant difference in AO-OTA fracture types in the two groups in terms of gender, operation time, BMI, and postoperative complications (p>0.05) (**Table 2**).

Table 2. Comparison of the fracture types according to AO/OTA with clinical features of patients.

	AO – PFN	AO - BPH
	P value	P value
Age	.097	.025*
Gender	.284	.490
Fracture mechanism	.001*	.153
Operation time	.935	.277
BMI	.280	.240
T-score	.118	.046*
Postoperative complication	.211	.405

*Significance; p<0,05

From a functional point of view, HHS was better in the BPH group compared to PFN at 6 months (p<0.05), but there was no difference between the two groups at the end of one year (p>0.05) (**Table 3**). Also, there was no difference between the two groups in terms of preoperative HHS (p>0.05). When we compare the scoring made in the postoperative periods with the preoperative period, although it was seen that there was a positive relationship in itself, the patient scores could not reach the preoperative levels (**Figure**) (**Table 4**).

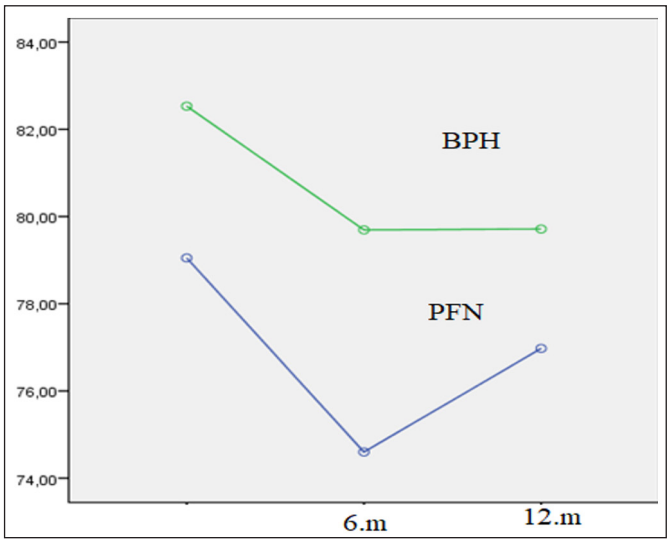

Figure. In two groups, preoperative and postoperative 6th-12th. month HHS comparison.

Table 3. Comparison of the implant types and HHS

Month	PFN	BPH	p value
	Mean±Sd	Mean±Sd	
Harris Hip Score			
6.	74.6±6.05	79.69±5.99	.001*
12.	76.98±6.22	79.71±7.18	.061
Preoperative Harris Hip Score	79.05±6.16	82.53±5.53	.188

*Significance; p<0,05

Table 4. The correlation of preoperative and postoperative HHS with implant types

Month		Preoperative Harris Hip Score	
		PFN	BPH
Harris Hip Score			
6.	r	.960*	.873*
	p	.001	.001
12.	r	.968*	.946*
	P	.001	.001

*Significance; p<0,05 r ; correlation

DISCUSSION

Femoral intertrochanteric fractures, which are frequently seen based on osteoporosis in the elderly, maintain their importance in terms of high mortality and morbidity. The majority of hip fractures are observed in adults over the age of 65, and half of these

fractures are in the intertrochanteric region, and they are more common in women. It usually develops as a result of high-energy events such as traffic accidents and falling from a height in the young age group, and as a result of low-energy injuries such as simple falls in the elderly (8). It was shown in a study that major traumas such as traffic accidents caused these fractures more than factors related to falling (9). In this research, the average age of all patients with intertrochanteric fracture was 68.16±6.78, whom we divided into two groups by applying PFN and BPH in the treatment, but the average age of the PFN group was younger than the BPH group, the fracture mechanism was mostly due to low energy, and our data are consistent with the literature. We attribute the almost equal distribution of gender in this type of fracture in our region, to the fact that men take a less active role in work activities but face more injury risks, and low functional mobility increases the susceptibility to hip fracture (10).

It was shown that advanced age and low socioeconomic level negatively affected mobility (11). Patients over 75 years of age generally have osteoporosis, slow fracture healing, bedridden complications, and high mortality rates (3). In this study, most of the patients had more than one additional disease and wound site, DVT, urinary-pulmonary infection, bedsore, and implant-related postoperative complications were observed. We attribute the lack of difference between the two groups in these respects to the unique characteristics of the fractures in this region.

Intertrochanteric fractures are classified to figure out the long-term clinical prognosis of implants, provide direction for various surgical procedures, and indicate fracture stability (12). Although the prevalence of AO/OTA 31-A3 fractures is limited, the rate of implant failures in these fractures is higher than in AO/OTA 31-A2 and A1 fractures (13). In this study, most fractures in the two groups were 3A2, and the fact that we did not see any difference between the surgical option and the fracture types showed us that our implant option was not the only one in all types of fractures in this region. The fact that most of the 3A1 and 3A2 fracture types in the PFN group were with low energy, and 3A3 with high energy, will guide the prevention of the severity of injuries in the 3A3 fracture type with high complications (13, 14). In addition, the fracture type we had BPH was 3A2 in those with the highest age and the lowest T score, whereas we did not detect any difference in these parameters in the PFN group, showing us that we can use PFN in most fracture types including these parameters.

The incidence of osteoporosis increases with the aging population (15). Some studies have shown that osteoporosis has negative consequences in intertrochanteric fractures (16). The important points in this type of fracture are early mobilization, full-weight bearing, and firm stabilization. However, the fact that most of the patients are advanced age and osteoporotic has a great impact on implant complications and morbidity (17, 18). Failure to attain early weight-bearing is well documented, especially in the case of this fracture kind, which affects old individuals (19, 20). It was stated that early administration of intravenous bisphosphonate treatment in individuals with an intertrochanteric fracture was a safe way for managing osteoporosis. In impoverished nations, osteoporosis care is frequently overlooked due to reasons such as insufficient awareness and financial constraints (21). In this study, while in the BPH group on the first postoperative day, full weight-bearing was achieved, it was at 3.48±0.78 months in the PFN group. Our BPH application in the group with a lower T-score and the complications related to implants and bedsores in the PFN group are consistent with the literature and show that we consider early mobilization.

It was found that high BMI was a protective agent against hip fractures, whereas limited functional mobility was a potential risk for hip fractures (10). Studies which found that higher BMI values were related to a decreased frequency of hip fractures supported the relevance of good nutrition (22). They reported that individuals having intracapsular fractures had lower BMI ratings than those with intertrochanteric fractures (23). At most, 20% of individuals with intertrochanteric fractures had BMIs below 18 kg/m2, compared to almost 50% of them with intracapsular fractures. In this study, the mean BMI >25 kg/m2 in both groups indicates that there may be other risk factors in fractures of this region within the scope of protection.

The Mini Nutritional Assessment (MNA) identifies poor nutritional status as a high-risk factor for fracture development in any area of the body (24). The advantages of good/healthy nutrition as functioning, comorbidity, and outcome, were also observed in other studies related to hip fractures (25). Good nutrition may be linked to a lower risk of fractures and a faster functional recovery from hip fractures. Albumin is a good marker as an indicator of malnutrition (26). It was found that albumin levels could not indicate improved functional results independently (27). In this study, albumin values were below the average in both groups, but we attribute the higher albumin in the PFN group compared to the BPH group to the lower mean age of the patients in this group.

In a study about PFN and hemiarthroplasty, they showed that in the elderly, the PFN group had a longer operation time (28). In contrast, They reported that the surgery time in PFN patients was less than in the hemiarthroplasty group in the elderly (8). This difference in the literature

may be due to reasons such as fracture reduction, implant differences, and surgical ability. In another study, they reported that the PFN group's surgery time and intraoperative blood loss were much less than those of the hemiarthroplasty group, with no significant difference related to average hospital stay between the two groups (5). It was reported that despite the reduced surgery duration, the quantity of postoperative and intraoperative early bleeding was greater in hemiarthroplasty patients (1). Controlling hemodynamics in patients with a high ASA score and a requirement for postoperative intensive care has been highlighted as a challenge. In this study, operation time, hospital stay, and Hb decrease levels were observed to be much lower in the PFN group than in the BPH group. Although there was no difference between the two groups on these results concerning ASA scores and anesthesia type, we think that the closed method of most of the surgeries in the PFN group was effective on the results.

They showed that the rates of DVT and pulmonary embolism were significantly higher in BHA according to PFN (1). In another study, they reported no significant differences between the two groups in postoperative complications such as bedsores, DVT, lung infection, and urinary tract infection (5). It was also found that no late postoperative infections in either the BHA or PFN individuals, however early postoperative wound infection rates were comparable (29). Although bedsore, wound site, and implant-related issues were more prevalent in the PFN group in this research, no difference in postoperative problems in general among the two groups has been detected. As a result, the surgeon's preference and expertise may be used to evaluate each case and choose the best treatment technique.

They showed that higher HHSs were observed in the hemiarthroplasty group for up to six months and higher levels at twelve months in the PFN group (8). At 18 months, both groups' values increased, but the PFN group's growth was greater. According to research, higher albumin of serum, younger age, and Activities of Daily Living (ADL) at discharge were all linked to greater hip function, as defined by HHS (30). They stated that the pre-injury function was favorably connected to treatment response. It was found that as people aged, their HHS decreased, as well (20). The hip function was linked to older age, which was a non-modifiable and independent risk factor (30). In this study, the mean age was higher in the BPH group. Although there was no difference between the preoperative HHS in the two groups, the HHS was better at 6 months in the BPH group than in the PFN group, but there was no difference between the two groups at the end of one year. There was a positive correlation between the preoperative and postoperative HHS. Since this scoring includes many parameters in itself, it provided better scores in the BPH group compared to the PFN group in the early period and showed that other factors should be considered in the evaluations.

The limitations of this study were that it was carried out in a single center, the small sample size, the retrospective nature of the research, and the inability to compare with other surgical methods used in the treatment of fractures in this region.

CONCLUSION

While most studies investigated risk factors for intertrochanteric fractures, they focused more on unstable fractures (12,30). This study will contribute to the literature as it covers all fracture types in the trochanteric region. Prognostic markers for treatment outcomes in individuals with intertrochanteric fractures are still unknown. It is important to determine the factors that will contribute to the long-term functional results in these patients. This research will add a different perspective to the literature in terms of comparing many parameters with patient function in intertrochanteric femur fractures.

ETHICAL DECLARATIONS

Ethics Committee Approval: This study was carried out with the permission of İstinye University Clinical Researches Ethics Committee (Date: 03/03/2022; Decision No: 3/2022.K-21).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

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